EMISSION REDUCTION OF CHLOROPICRIN AND 1,3-DICHLOROPROPENE WITH A GAS-BARRIER FILM

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Methyl Bromide (CH_3Br) is a major fumigant used in Japan to control soil-borne diseases in crops such as cucumbers, gingers, tomatoes, melons, green peppers, etc. The use of CH_3Br as a soil fumigant is to be phased out by 2005, but no new chemical or non-chemical alternative has yet emerged as its substitute. For now, chloropicrin, 1,3-dichloropropene and dazomet are seen as the best alternatives to CH_3Br. It is already difficult to satisfy demand for CH_3Br as a soil fumigant adequately, whereas there are not remarkable changes in the amount of 1,3-dichloropropene, chloropicrin and dazomet that have been used in major CH_3Br use areas. Under the Protocol, from 1 January 2003 a 70% cut in production and consumption of CH_3Br, based on 1991 levels, was done in Japan. Therefore, it is predicted that the consumption of these chemical alternatives will increase more.

Our monitoring results of fumigants in the atmosphere during several months in horticultural areas showed that even under the current situation, fumigants such as 1,3-dichloropropene, chloropicrin, methyl isothiocyanate (MITC) and CH_3Br of high concentration (over several hundred $\mu g/m^3$) were detected frequently, but these high concentrations were temporary, and most air samples contained several $\mu g/m^3$ of fumigants. Restrictions on CH_3Br usage required an intensive search for improved technologies to reduce both dosage and emission of alternative chemicals from fumigated plots into the atmosphere, while maintaining its effectiveness for disease and weed control and providing adequate safety for people who live and work in areas where soil fumigations occur to multiple fields.

The purpose of this study was to improve fumigation technologies under Japanese horticultural conditions, to reduce dosage and emission of alternative chemicals from fumigated plots into the atmosphere, while maintaining its effectiveness for disease and weed control. This technique is the use of a gas-barrier film such as VIFs (Very Impermeable Films). We evaluated the volatilization dynamics and emission loss rates of 1,3-dichloropropene and chloroicrin, compared with a conventional polyethylene (PE) film, under field conditions to allow various environmental conditions.

Emission losses of chlorpicrin and 1,3-dichloropropene were evaluated in field experiments from 11 June in 2001 on Hydric Hapludand soils at the National Institute for Agro-Environmental Sciences, Tsukuba, Japan. "Manual injection

method" was used for applying the "Dorochlor(80% chloropicrin, 20.2 g/m^2)"-"D-D(92 % 1,3-dichloropropene, 17.2 g/m^2)" mixture (in a volume ratio 1:1) into soil depth of ca. 17cm. Treated areas were 15 m^2 (2.5 m x 6 m), which were immediately covered with a VIF (Barrier-Star®: ethylene-vinylalcohol copolymer, 0.05mm thickness, Tokankosan Co, Ltd.) and a conventional PE film (0.05mm thickness) respectively, then removed after 7 days (11 June). An automated gas chromatography system, equipped with flame ionization detectors (GC-FID) and four 7.5 L chambers (diam. 24.5 cm) was used to determine emission flux. The chambers were placed directly on the film or soil surface. Concentrations of chloropicrin, cis- and trans-1,3-dichloropopene in the air below the film and at soil depths of 30, 60, 90, 120, 150 cm were measured.

Fig. 1 shows the volatilization dynamics and emission loss rates of chloropicrin and 1,3-dichloropropene. The maximum emission flux reached about 123 mg/m^2/hr and 115 mg/m^2/hr for chloropicrin and 1,3-dichloropropene with a PE film and 9.95 mg/m^2/hr and 8.40 mg/m^2/hr with a VIF, respectively. This maximum was reached after three days that injected and then the emission rate decreased slowly. The emission flux follows a diurnal pattern with large fluxes near solar noon when the temperature was high and low emission was near midnight with low temperatures. The emission rates were dependent on solar radiation, temperature and chemicals' concentration below films. Our experiments also showed that emission losses reached, respectively, about 42.7 % and 49.3 % of the applied amounts for chloropicrin and 1,3-dichloropropene with a PE film. However, in the case of a VIF, emission losses reduced to 7.8 % and 6.6%, respectively. Because Japanese growers generally don't use covering materials in the case of D-D fumigant, it is predicted that actual loss of 1,3-dichloropropene to the atmosphere is bigger than this estimate. This technique can be a simple but effective method in reducing emissions of alternative fumigants into the atmosphere in Japan.

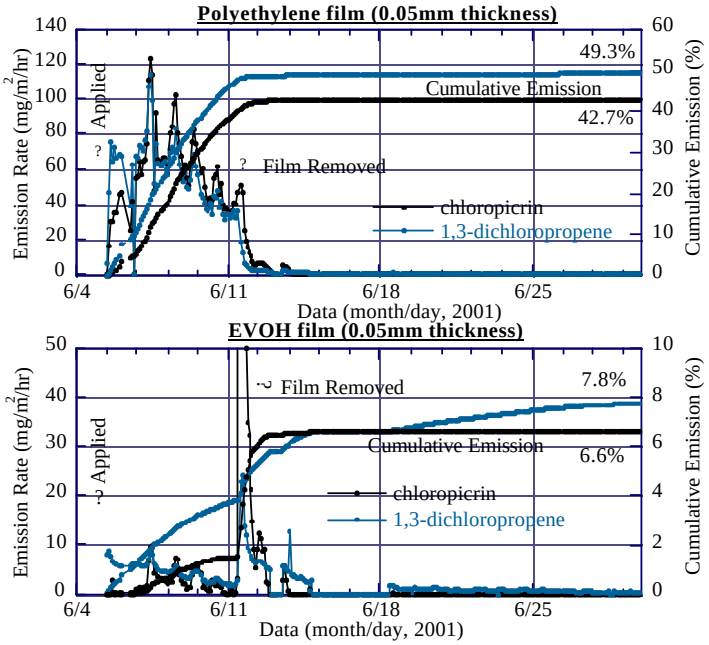

Figure 1. Chloropicrin and 1,3-dichloropropene emissions to the atmosphere. Data points are means of each two measurements. Soil was covered with a polyethylene film (0.05 mm thickness) and ethylene-vinylalcohol copolymer (0.05mm thickness) for 7 days and removed.
1,3-dichloropropene = **cis**-1,3-dichloropropene + **trans**-1,3-dichloropropene